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Nonsymbiotic haemoglobins in plants.

Sowa AW, Guy PA, Sowa S, Hill RD.

Plant Breeding and Acclimatization Institute, Radzikow, Blonie, Poland.

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General aspects regarding the presence of nonsymbiotic haemoglobin in plants are presented with the emphasis on those related to its function. As it becomes apparent that the nonsymbiotic haemoglobins are widespread across the plant kingdom and that they represent a more primitive and evolutionary older form of the plant globin genes, the question of their function becomes more attractive. While the physiological functions of the symbiotic haemoglobins in plants are well understood, almost nothing is known about their nonsymbiotic predecessors. Therefore, the known and hypothetical functions of haemoglobins in various systems are described along with information concerning properties and the regulation of expression of the nonsymbiotic haemoglobins. Interestingly, a number of nonsymbiotic haemoglobins have been shown to be hypoxia-inducible. The spatial and temporal pattern of this induction in barley may suggest that it is an integral part of the plants response to limiting oxygen stress.

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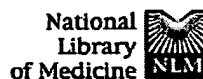
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A nonsymbiotic hemoglobin gene is expressed during somatic embryogenesis in Cichorium.

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Hendriks T, Scheer I, Quillet MC, Randoux B, Delbreil B, Vasseur J, Hilbert JL.

Laboratory of Plant Breeding, Agricultural University Wageningen, P. O. Box 386, 6700 AJ Wageningen, The Netherlands.

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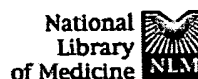
After differential screening of a cDNA library corresponding to genes expressed during the early stages of somatic embryogenesis in leaf tissue from the Cichorium hybrid '474' (*C. intybus* L., var. *sativum* × *C. endivia* L., var. *latifolia*) a nonsymbiotic hemoglobin cDNA was obtained. Studies of the expression of the gene corresponding to this clone by Northern blot analysis suggest that in Cichorium a nonsymbiotic hemoglobin gene is specifically expressed under somatic embryogenesis-inducing conditions, and that its expression is not related to stress caused by wounding or tissue culture conditions.

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Quaternary structure of rice nonsymbiotic hemoglobin.
J Biol Chem. 2001 Mar 2;276(9):6834-9.
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Genomic analysis of a nutrient response in Arabidopsis reveals diverse expression patterns and novel metabolic and potential regulatory genes induced by nitrate.
Plant Cell. 2000 Aug;12(8):1491-509.
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☐ 4: Trevaskis B, Watts RA, Andersson CR, Llewellyn DJ, Hargrove MS, Olson JS, Dennis ES, Peacock WJ.

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Two hemoglobin genes in Arabidopsis thaliana: the evolutionary origins of leghemoglobins.
Proc Natl Acad Sci U S A. 1997 Oct 28;94(22):12230-4.
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☐ 5: Andersson CR, Llewellyn DJ, Peacock WJ, Dennis ES.

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Cell-specific expression of the promoters of two nonlegume hemoglobin genes in a transgenic legume, Lotus corniculatus.
Plant Physiol. 1997 Jan;113(1):45-57.
PMID: 9008386 [PubMed - indexed for MEDLINE]

☐ 6: Anderson CR, Jensen EO, Llewellyn DJ, Dennis ES, Peacock WJ.

Related Articles, Nucleotide, **Free in PMC**, Protein

A new hemoglobin gene from soybean: a role for hemoglobin in all plants.
Proc Natl Acad Sci U S A. 1996 Jun 11;93(12):5682-7.
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☐ 7: Jacobsen-Lyon K, Jensen EO, Jorgensen JE, Marcker KA, Peacock WJ, Dennis ES.

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Symbiotic and nonsymbiotic hemoglobin genes of Casuarina glauca.

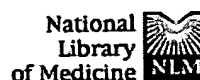
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Symbiotic and nonsymbiotic hemoglobin genes of *Casuarina glauca*.

Jacobsen-Lyon K, Jensen EO, Jorgensen JE, Marcker KA, Peacock WJ, Dennis ES.

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Casuarina glauca has a gene encoding hemoglobin (cashb-nonsym). This gene is expressed in a number of plant tissues. *Casuarina* also has a second family of hemoglobin genes (cashb-sym) expressed at a high level in the nodules that *Casuarina* forms in a nitrogen-fixing symbiosis with the actinomycete *Frankia*. Both the nonsymbiotic and symbiotic genes retained their specific patterns of expression when introduced into the legume *Lotus corniculatus*. We interpret this finding to mean that the controls of expression of the symbiotic gene in *Casuarina* must be similar to the controls of expression of the leghemoglobin genes that operate in nodules formed during the interaction between rhizobia and legumes. Deletion analyses of the promoters of the *Casuarina* symbiotic genes delineated a region that contains nodulin motifs identified in legumes; this region is critical for the controlled expression of the *Casuarina* gene. The finding that the nonsymbiotic *Casuarina* gene is also correctly expressed in *L. corniculatus* suggests to us that a comparable non-symbiotic hemoglobin gene will be found in legume species.

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